Assessment of the Low Contrast Detectability of Multi-slice CT Scanners

Nicholas Keat, Maria Lewis, Julia Carden, Sue Edyvean, David Platten
ImPACT*, St George’s Hospital, London
*An MDA device evaluation group
www.impactscan.org
Clinical importance of LCD in CT

- Studies where soft tissue differentiation is important are common in CT

- Abdomen, Pelvis: 26%
- Cerebrum: 22%
- Spine: 20%
- Mediastinum: 7%
- Lung parenchyma: 6%
- Trauma: 5%
- Interventions: 4%
- Base of skull: 3%
- Pediatrics: 3%
- Orthopedics: 3%
- Inner ear: 1%

Contrast resolution more important in ~90%

Spatial resolution more important in ~10%
Assessment of LCD

• Generally use uniform phantoms with variable size low contrast inserts
Why use the Catphan?

• Catphan is probably closest to a ‘standard’ phantom for LCD assessment
• Manufacturers’ published LCD data is usually on the Catphan
  – Smallest visible detail size (mm) for 3 HU (0.3%) contrast
  – Dose given by CTDI measured on the Catphan surface
## Manufacturers’ LCD performance data

<table>
<thead>
<tr>
<th>Scanner</th>
<th>GE</th>
<th>Philips</th>
<th>Siemens</th>
<th>Toshiba</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LightSpeed +</td>
<td>Mx8000</td>
<td>Volume Zoom</td>
<td>Aquilion Multi</td>
</tr>
<tr>
<td>Phantom</td>
<td>Catphan</td>
<td>Catphan</td>
<td>Catphan</td>
<td>Catphan</td>
</tr>
<tr>
<td>Contrast</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Slice width</td>
<td>2 x 10 mm</td>
<td>10 mm</td>
<td>1 x 10 mm</td>
<td>10 mm</td>
</tr>
<tr>
<td>Surface Dose</td>
<td>18 mGy</td>
<td>27 mGy</td>
<td>21 mGy</td>
<td>120 kV, 150 mAs*</td>
</tr>
<tr>
<td>Detail Size</td>
<td>5 mm</td>
<td>4 mm</td>
<td>5 mm</td>
<td>4 mm</td>
</tr>
<tr>
<td>Detail visibility criteria</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

*ImPACT estimated CTDI: 24 mGy

- Data not directly comparable
- Variable visibility criteria will always be a problem
Visibility Criteria

- When does a detail become visible?

Doses given are CTDI measured at surface of Catphan
Comparison of LCD on different scanners

- ImPACT have compared LCD for four slice scanners using equivalent scan parameters
  - 120 kV, 2 x 10 mm slice thickness, 25 mGy surface CTDI, 20 images per scanner
  - Reconstructed using 250 mm FOV, and standard brain reconstruction algorithm (no bone correction)
Image scoring

- Custom program written in IDL to allow user to score all 80 images, presented in a random order.
Reading images

- 20 images presented for each scanner, and the 0.3% contrast details scored for visibility
- Users allowed to select window level and width
- Written criteria for visibility of objects
  - ‘The criteria for visibility of a detail is whether the observer is sure that there is an object visible against the background. This does not mean that they need to be able to see a circle, but it must be plain that what they are seeing is not just image noise patterns.’
- Lighting and monitor set up controlled
Presentation of results

• e.g. from 20 images:
  – 15 mm detail is visible in all 20: 100 % visibility
  – 7 mm detail visible in 13 images: 65 % visibility

• etc...

![Graph showing visibility vs. detail size with Better LCD towards left]
Results

- Results from 5 viewers for 1 scanner
LCD for different scanners

- Average scores of 5 viewers for 3 scanners

- Standard deviation of scores very high!
Are all scanners the same?

- Individual scores show similar general trends

Scorer 1

Scorer 2

Scorer 3

Scorer 4

Scorer 5

CTUG 2002
LCD and dose

- 20 images at each of 6 dose levels, single viewer
Conclusions

• Very difficult to establish definitive LCD figures
  – comparisons of LCD should only occur when images are viewed at the same time, by the same viewers

• It is possible to establish relative LCD values under controlled conditions
  – Results suggest that fundamental differences in LCD for four slice scanners are not huge, when using Catphan
It is important to bear in mind that:

LCD details in phantom do not represent clinical situation
  – details within patients are not always round, with sharp edges in a predefined position!

Results are not a ‘definitive’ assessment of LCD - there is no right or wrong answer!
Thank you

• Colleagues in ImPACT who read the images
• Scanner manufacturers for their cooperation
• Hospitals who allowed their scanners to be used for testing

• Slides from this talk are available at www.impactscan.org